Short note

Bryozoan encrusted plastic from the continental slope: eastern South Island, New Zealand

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Abstract

A small flake of plastic sheeting recovered from the upper continental slope to the east of the South Island, and upon which was growing a colony of the celeporid bryozoan *Galeopsis mimicus*, is symptomatic of broader environmental problems associated with marine debris accumulation on the deep sea floor.

Keywords: encrusting bryozoan - marine debris - plastic litter - deep sea floor - New Zealand.

Introduction

Over the past 30 years there has been much documentation of the extent to which oceanic surface waters have become increasingly contaminated by plastics and other persistent synthetic materials (i.e., marine debris). Research has largely focussed on quantifying amounts and distribution patterns, establishing types of litter and their sources, evaluation of environmental, aesthetic and commercial impacts, and finding (or speculating about) solutions. The problems are particularly manifest in coastal waters and along shorelines. These aspects, together with possible answers, are comprehensively reviewed in Coe and Rogers (1997). The commonly identified sinks for this plastic litter are either burial in beach and backshore settings by drifting sand, or fragmentation through photodegradation-induced embrittlement into fine powders that pass from view and are assimilated into the environment. It is also accepted that onshore winds may disperse plastic sheeting and other light material, including foamed polyethylene and polystyrene, across coastal hinterlands.

Although Williams *et al.* (1993) and Goldberg (1997) have recently emphasized that the sea floor, from intertidal and shallow sub-littoral zones to greater depths, is an important sink for marine debris, aspects of its significance in all these settings have been appreciated for some time (e.g., Holmström 1975, Harms 1990). Over the past few years, records of plastics and other anthropogenic debris accumulating on the sea floor at varying depths have increased. The localities include Antarctica (Lenihan *et al.* 1990); the Bay of Biscay and elsewhere in European waters (Galgani *et al.* 1995a, Galgani *et al.* 2000); the western (Galgani *et al.* 1995b, Galgani *et al.* 1996) and eastern Mediterranean (Bingel *et al.* 1987, Galil *et al.* 1995, Stefatos *et al.* 1999); Alaska (Hess *et al.* 1999); California (Moore & Allen 2000); Indonesia (Uneputty & Evans 1997); Japan (Kanehiro *et al.* 1996) and South Africa and New Zealand (Gregory & Ryan 1997, Backhurst & Cole 2000). The above studies typically record larger (macro- megascopic), readily visible plastic items. Thompson *et al.* (2004), have recently demonstrated that quantities of microscopic plastic fragments and fibres associated with plankton in surface waters have significantly increased since the 1960's, and also that these materials are dispersed through the water column. Such widely distributed occurrences suggest environmental impacts whose magnitude and significance have yet to be fully appreciated (see Goldberg 1997) or explored (e.g., Thompson *et al.* (2004).

While diverse biotas of fouling organisms and encrusters are known from pelagic (i.e., floating) plastics (e.g., Winston 1982, Klausewitz 1984, Ye and Andrady 1991, Stevens *et al.* 1996, Winston *et al.* 1997), similar studies of benthic (i.e., that which has settled on to the sea floor) materials are limited (e.g., Holmström 1975, Harms 1990, Powlik 1995). The scant evidence presently available, however, suggests typical temperate hard ground communities characterised by bryozoans, hydrozoans, sponges and foraminifera, as well as barnacles, bivalves and polychaetes, form the basis for epibiontic communities. At shallow depths in the photic zone, crustose (coralline) red algae together with soft brown and green algae are often common. Bryozoans are generally a conspicuous, if not dominant, epibiont of both pelagic and benthic marine debris (e.g., Stevens 1992, Barnes & Sanderson 2000).

Material

While picking benthic and planktic foraminifera in bottom sediment samples taken from a number of New Zealand Oceanographic Institute [NZOI now NIWA] grab and core stations, as well as at several ODP sites, lying in water depths between 90 m and 4600 m to the east of Banks Peninsula, South Island, New Zealand and across the Chatham Rise (Figure 1), small flakes of frayed and shredded plastic sheeting were encountered on two occasions. One of these came from the surficial 1-2 cm of

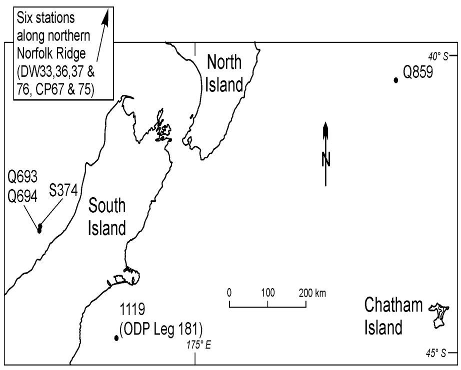

Figure 1. Central New Zealand, showing local sampling stations referred to in the text. (inset: northern Norfolk Ridge and South Loyalty Basin stations, DW33, 36, 37 and 76; CP67 and 75; see Gordon and d'Hondt, 1989).

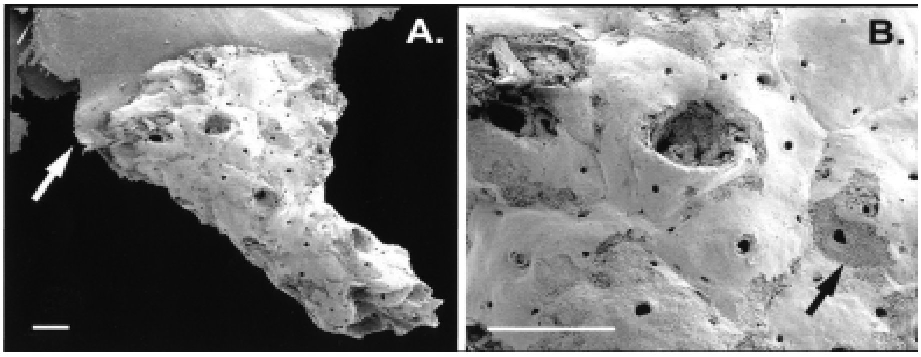

Figure 2. The cheilostome bryozoan *Galeopsis mimicus* on the frayed plastic substrate (arrowed) to which it is attached (A) and enlarged showing characteristic surface evident (arrowed) (B). Scale bar 200 μm.

an ODP Leg 181 core taken on the upper continental slope at site 1119 (position 44° 45.33'S / 172° 23.60'E), located in the South Canterbury Bight, some 60 km offshore and at a water depth of 393 m. The flake's dimensions are c.9 mm x 6 mm. This flake is worthy of note because of a small celleporid bryozoan that was attached to it (Figure 2). Despite being somewhat abraded the specimen has been tentatively identified as *Galeopsis mimicus* Gordon 1989. Previous records of this taxon in New Zealand waters are at depths of between 297 m and 520 m a short distance off the coast of Westland (NZOI stations Q693 and 694, S374; Figure 1) where it has been found only on the aboral spines of the frontal notch of the echinoid *Spatangus multispinus* Mortensen (Gordon 1989). It is also known in waters >2000 km to the north of New Zealand, where it occurs between depths of 470 m and 825 m from six stations immediately south of New Caledonia and lying between latitudes 24° 55'S and 22° 18'S along the South Loyalty Basin and northern Norfolk Ridge. Here it occurs on axes of small gorgonians (Gordon & d'Hondt 1997). This species seems to like thin structures to settle on and a plastic flake could be ideal (Gordon, pers comm. 2000). The recorded depth range for *G. mimicus* suggests that it colonised the plastic substrate while it lay on the sea floor and that it is unlikely to have been transported from shallower, up-slope depths. It can also be noted that this is the first record of *G. mimicus* in waters to the east of New Zealand. Dredgings from this region have not, however, been extensively sampled for bryozoans.

In 66 samples examined, the only other plastic artifacts to be found came from NZOI station Q859 (water depth 3654 m: position 39° 56.24' S / 178° 30.48' E) (Figure 1). These were thread-like scrapings, devoid of any bryozoan encrustation or evidence of attachment scaring, and careful examination suggests contamination from the plastic liner during the core-splitting process.

Discussion

This fortuitous discovery is a further example of plastic reaching the deep sea floor and, once there, providing a suitably substantial or firm substrate for colonisation by fouling epibionts. In general, sheet and other plastic products are positively to neutrally buoyant, and that significant quantities can reach the deep sea floor is something that many find surprising (e.g., Holmström 1975). The mechanisms by which they do so are poorly understood. For instance, an example is Oshima's (2000) observation of a fleet of flimsy white plastic, supermarket shopping bags, up-ended and suspended at depths of 2000 metres, and drifting like an assembly of ghosts. From experimental evidence, Ye and Andrady (1991) and Stevens (1992) have argued that rapid and heavy fouling of plastic materials may lead to density increases sufficient to permanently sink them. These authors also recognised that cleaning of fouled surfaces by grazers can lead to cyclic episodes of submergence and resurfacing until permanent settlement to the seafloor takes place. It is also possible that plastic sheeting and other items may attract or act as a passive collection surface for non-living particulate detritus. This, together with photodegradation and embrittlement leads to the density increases necessary to take plastic items to the sea-bed (Powlik 1995) without invoking down-welling and entrainment processes.

The presence of plastic sheeting and other large plastic items, as well as discarded fishing gear on the sea floor is undesirable and likely to be environmentally damaging (Williams *et al.* 1993, Goldberg 1997). It must however be recognised that hard grounds, even small-scale ones, will attract a biota different from that of adjacent soft, muddy substrates. It seems ironic to suggest that plastic artifacts reaching the seafloor could enhance local biological richness and diversity in the short term, although in the long term this material is doomed for permanent entombment in slowly accumulating sediment.

Conclusions

The occurrence of *Galeopsis mimicus* on a flake of plastic sheeting recovered from the deep seafloor may be viewed by some as little more than an interesting curiosity, similar to the beach-cast virgin plastic granule from northern New Zealand that hosted the bryozoan *Membranipora tuberculata* which was illustrated by figure 8 in Gregory (1978). It was inferred that arrival of the latter taxon was by way of eastwards dispersal from Australian waters and across the northern Tasman Sea in eddies of the East Australian Current (Gregory 1978). Both, however, can be considered to be evidence symptomatic of much wider problems, and ones having potentially serious environmental implications. Passively drifting, discarded plastic materials may be colonized by a diverse community of encrusting and fouling epibionts (Stevens 1992, Winstone *et al.* 1997). This cargo of hitch-hikers and hangers-on may include aggressive and invasive marine species. Rafting of alien taxa rafted in this way could endanger environments both near and far from their natural habitats (Winston 1997, Gregory 1998, 2004). Similarly, plastic debris could be a vector effecting the introduction of aggressive alien taxa into regions that hitherto have been considered impenetrably deep.

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